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(54) Alignment system for line replaceable modules

(57) A pair of track members (24) is fastened to a framework (12) of a black box (10) forwardly of each mother board connector (16) of an array thereof mounted on the mother board (14) of the black box (10). The track members (24) extend forwardly in parallel from end flanges of the connector (16) to leading ends fastened to the black box framework (12) at the LRM-receiving front aperture, so that an LRM (18) placed between the pair of tracks (24) is movable to the mother board connector (16) for mating of the LRM connector (20) therewith. The trailing ends (30) of the track members (24) extend through precisely located holes through the end flanges of the mother board connector (16) and through the mother board (14) after which the end portions (30) are fastened to frame members (32) behind the mother board (14). The track members (24) can be hollow enabling fluid to be circulated therethrough to dissipate heat from the LRM (18). The track members (24) can constitute the means to fasten the mother board connector (16) to the mother board (14), and also the mother board (14) to the framework (12) of the black box (10).

FIG.1

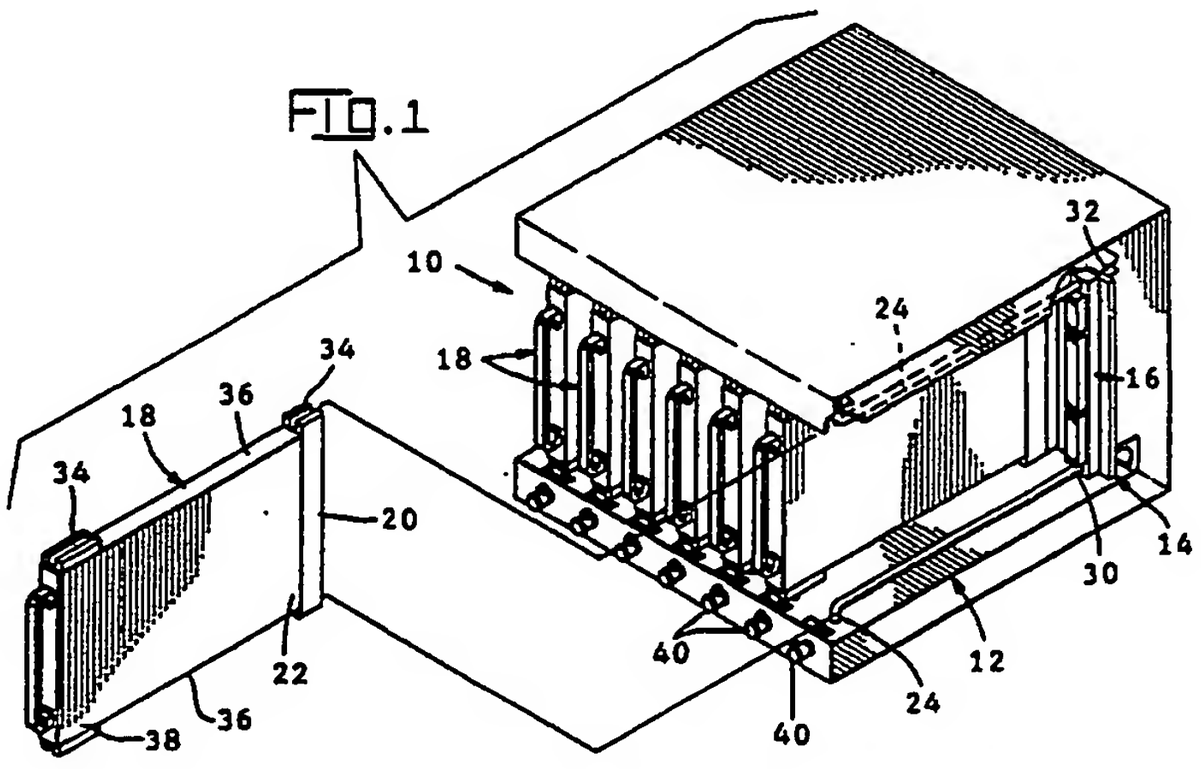

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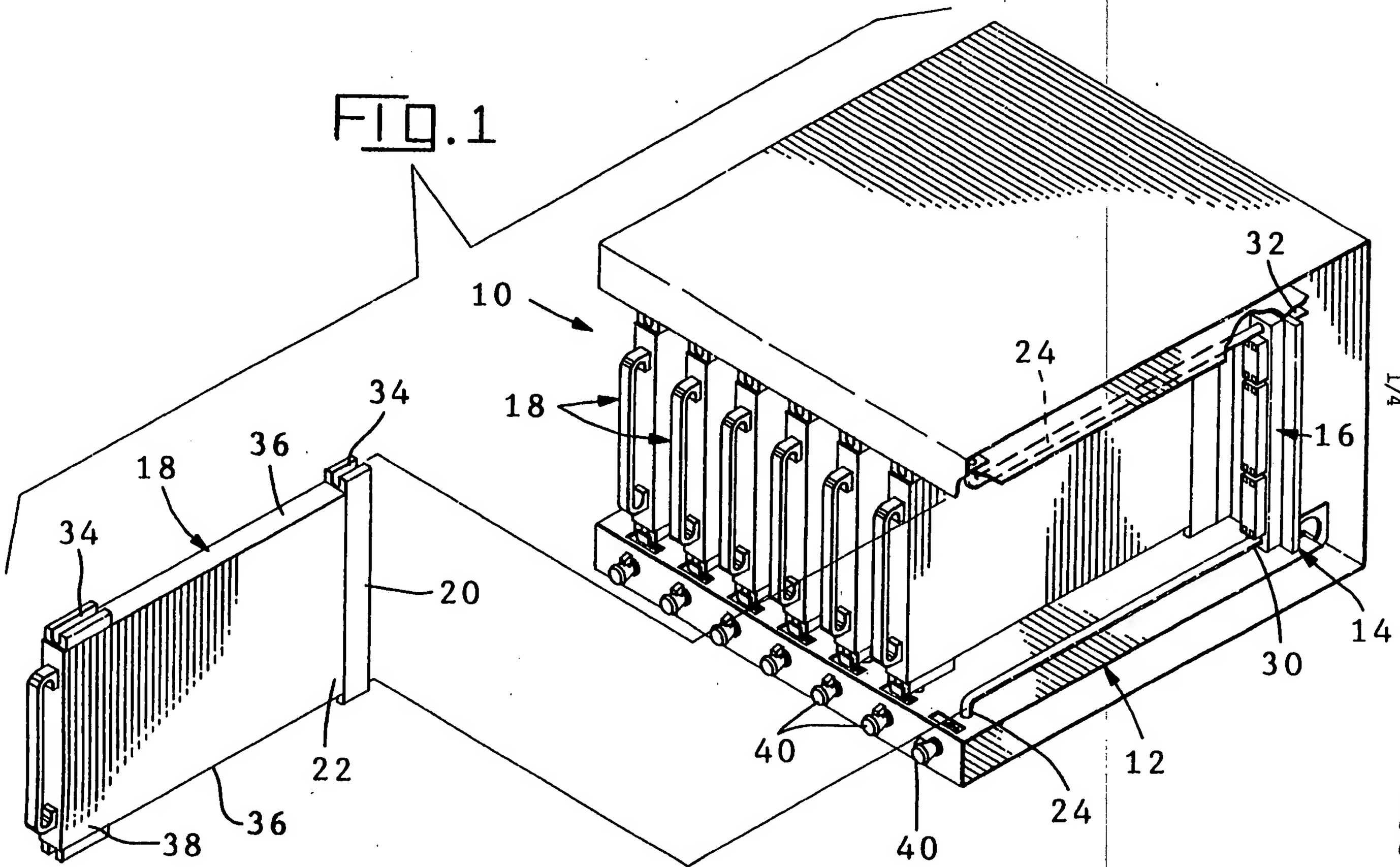
FIG.1



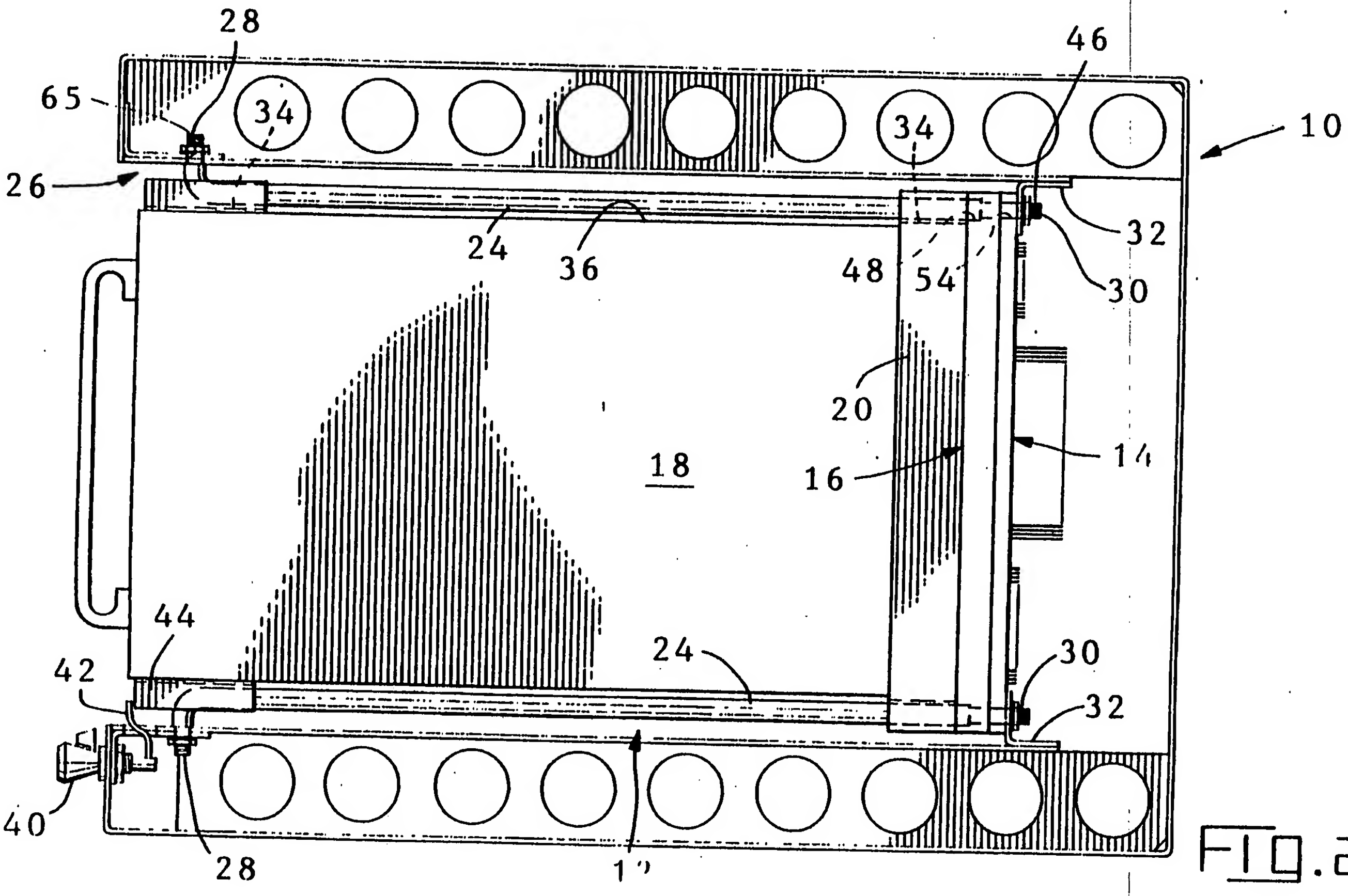


FIG.2

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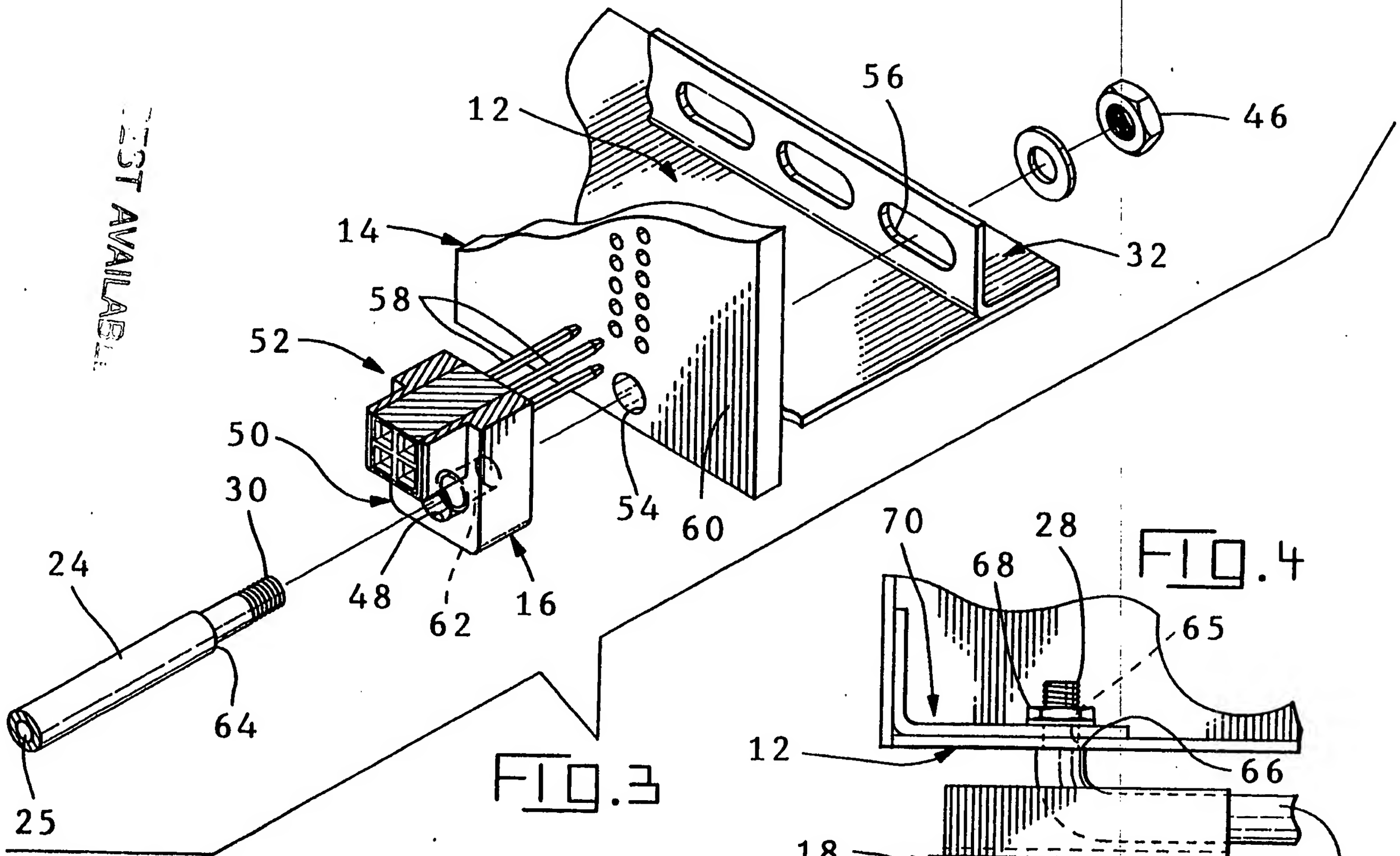

FIG.3

FIG.4

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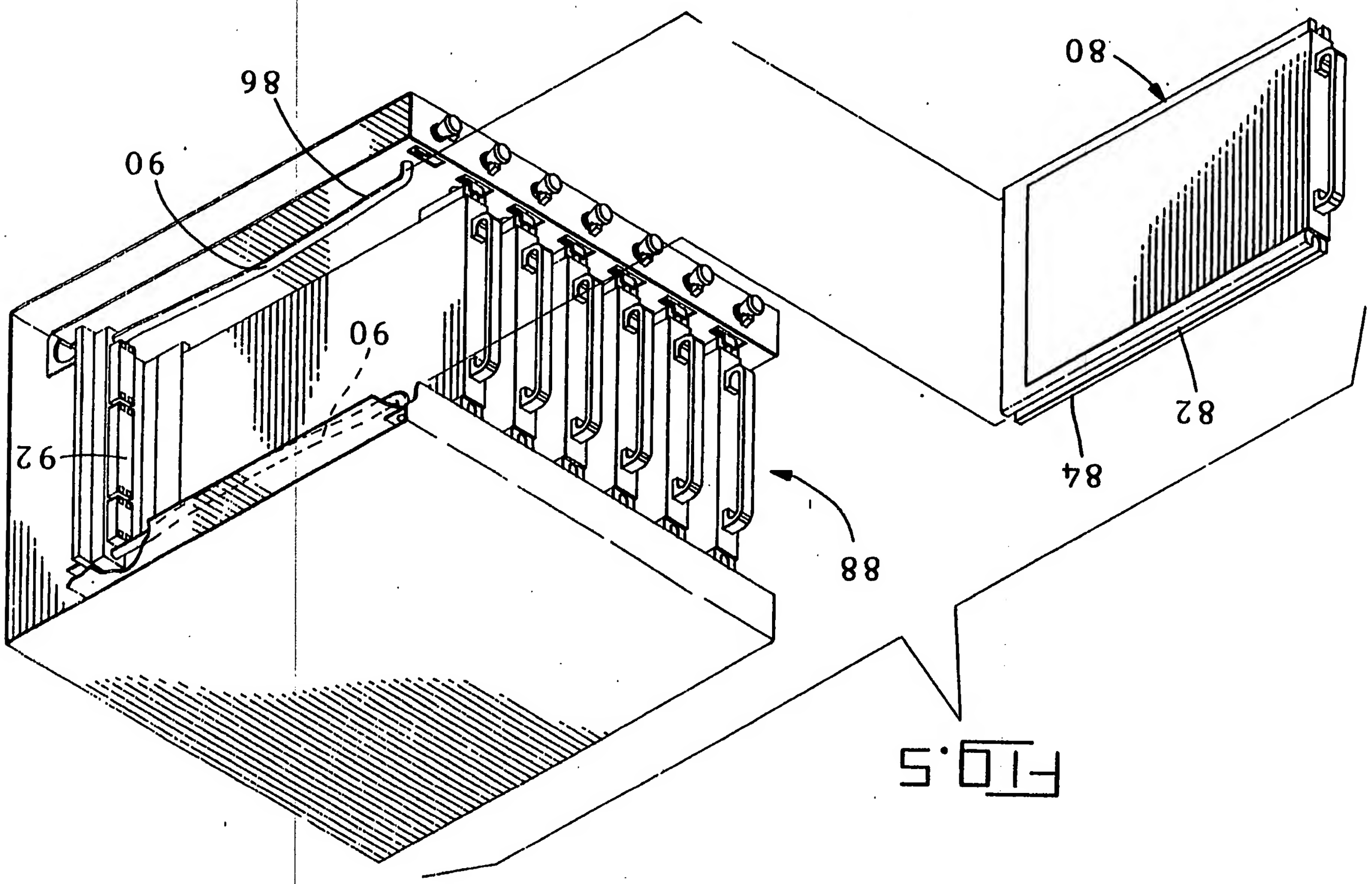

FIG.5

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ALIGNMENT SYSTEM FOR LINE REPLACEABLE MODULES

The present invention relates to the mating of electrical connectors and more particularly to aligning of connectors for proper mating.

Especially in the aircraft industry, it is becoming desirable that electronic control units, or "black boxes," each comprise a housing containing essentially a single circuit panel or mother board to which are electrically connectable a plurality of line replaceable modules on one surface and shipboard electrical systems on the other. Each line replaceable module, or LRM, performs a control or sensing or recording function and comprises essentially one or more circuit cards or daughter boards loaded with various electrical and electronic components, mounted to a heat sink plate and protected and shielded by cover plates. The LRM is intended to be a durable, rugged assembly capable of being handled and repeatedly inserted into and removed from a black box for testing, repair, modification or replacement

The plurality of LRM's are closely spaced in a side by side array within the black box and along the mother board; and each LRM has a small dimension along the array to facilitate such close spacing. The daughter card or cards and all of the electrical and electronic components connected thereto necessary in the LRM are secured to a heat sink plate disposed essentially along a plane transverse to the array of LRM's and extending rearwardly from the LRM connector at the forward end of the LRM, so that the LRM is long rearwardly and is wide transverse to the array. The electrical connector mounted on the forward end thereof has a mating face exposed to mate with the mating face of a corresponding one of a plurality of electrical connectors secured on the mother board mounted within the black box in a closely spaced array for efficient use of the real estate of the mother board. The

black box must be provided with guiding means along opposing side walls extending from the LRM-receiving opening to each mother board connector, to guide the long and wide LRM into lateral and axial alignment with the respective mother board connector for proper aligned mating of the connectors.

In one particular design of black box the guide means for each LRM comprises a pair of opposed channels formed in and along surfaces of plate members mounted along the side walls of the black box, and the cover plates of each LRM form a flange along each of its opposed side edges to be disposed in the guide channels therefor. The LRM flange is dimensioned just thin enough to permit movement along the channel without permitting side to side movement, for vibration resistance. Due to practical considerations the mother board with its precisely located circuitry cannot be mounted in the black box in such a way that its connectors are precisely aligned with the channels associated therewith which are already formed in the plate members of the black box. Therefore, the channel locations are not particularly precisely located with respect to the mother board connectors; the LRM flanges are constrained to move therealong which results in the LRM also being not particularly precisely aligned with the respective mother board connector. As a result, for this particular black box design either the mother board connector or the LRM connector must be capable of incremental lateral movement during mating to provide precise alignment of their terminals prior to terminal engagement.

Rack and panel or drawer connectors are known wherein one of a mating pair includes integral alignment posts extending forwardly therefrom to enter corresponding apertures of the other, for connector self-aligning during mating. At least one of the mating connectors is float

mounted either on a panel or on framework or a panel at the leading end of the drawer by shoulder screws through enlarged diameter holes through connector flanges, enabling incremental lateral movement caused by bearing engagement of the alignment posts and apertures. Such a connector is the METRIMATE Drawer Connector (trademark of AMP Incorporated, Harrisburg, Pennsylvania); another is disclosed in U.S. Patent No. 4,647,130; and in both the connectors contain terminals terminated to discrete conductors. However, the float mounting means of the prior art drawer connectors is not particularly suitable for either the mother board connector or the LRM connector, which in turn means that the alignment post and aperture arrangement thereof also is not suitable for use with LRM's.

Mother board connectors in the black box must be fixedly mounted to the mother board to protect the terminations of those of its terminals which are soldered to circuit paths of the board, and the LRM connector must be secured well enough to and within the cover plates of the LRM to protect the terminations of those of its terminals which are soldered to circuit paths of daughter cards fixedly secured to heat sink plates within the LRM. Each mating pair of the plurality of electrical terminals of the connectors across their mating faces must be precisely aligned to establish respective electrical connections therebetween; the connectors may also have optical fiber connectors similarly requiring precise alignment for establishing optical connections. One type of high density connector which can be adapted for use in an LRM is disclosed in U.S. Patent No. 4,715,829.

The terminal housing means of the LRM connector may be recessed within a shroud at the forward end of the LRM and secured within the cover plates against axial movement but permitted incremental lateral movement within a

peripheral gap around the inside shroud surface. An alignment rib can extend forwardly from the LRM connector housing means to enter a corresponding aperture in the mother board connector, and upon bearing engagement urge the LRM connector housing means incrementally laterally to align therewith.

It is desired to provide a guide means which is particularly precisely located and aligned with respect to the particular mother board connector with which the connector of an LRM is to mate, whereby the LRM is itself particularly precisely aligned with the mother board connector, and the connector housing of the LRM need not move incrementally within the LRM to align with the mother board connector, permitting an LRM of simpler construction and assembly.

According to the present invention, the guide means for each LRM comprises a pair of opposed tracks or rails secured to the framework of the black box and extending from the LRM-receiving opening thereof to the respective mother board connector mounted on the mother board secured within the black box. The LRM includes channel portions along opposed sides thereof within which the tracks are disposed enabling the LRM to follow the tracks during insertion into the black box. The end of each track at the mother board connector extends through a hole through an end flange of the connector, through a hole of the mother board aligned with the flange hole, and through a larger hole or slot of the frame member of the black box. The hole through the connector flange is precisely located with respect to the terminals thereof and is precisely dimensioned to just allow the track end to be inserted therethrough without allowing the track to move laterally therein.

The track is assembled to the black box by its connector end being inserted through the connector flange hole which precisely locates the track with respect to the connector, only after which is the connector end secured to the frame such as by a nut threaded onto the portion of the track end extending through the frame member. The other end of the track is secured at the LRM-receiving opening to a frame member of the black box, and can comprise a portion extending at a right angle outwardly to a stop shoulder and therepast through a hole of the frame member to a threaded end portion onto which a nut is secured. The stop shoulder engaging the inwardly facing surface of the frame member positions the track appropriately into the central portion of the black box to center the LRM. The track being as long as the LRM, any incremental angle with respect to the mother board connector caused by the other track end being secured in a frame member hole which is not very precisely located with respect to the mother board connector, is insignificant in its effect on axial alignment of the LRM and the LRM connector with the mother board connector.

According to another aspect of the present invention, the track can be a tube made of a metal alloy selected for its high heat conductivity and for spring characteristics. The track can be formed with a slight inward arcuate configuration along its length, so that during insertion of an LRM therealong the pair of tracks are deflected outwardly by the bottoms of the respective LRM channels and remain deflected applying spring bias against the channel bottoms assuring substantial surface contact therewith and thereby assuring a good thermal connection.

The tubular tracks can be connected to a coolant system, and their tubular nature enables fluid to be pumped therethrough. This arrangement enables the tracks to participate in conducting heat away from the LRM during

in-service use, and also can hold the side of the LRM away from the black box framework to facilitate air flow therearound.

It is an objective of the present invention to provide a guide means for precisely aligning the LRM's with corresponding mother board connectors during insertion into a black box, thereby eliminating the necessity of the LRM connectors to move incrementally to self-align with the respective mother board connectors.

It is another objective to provide a guide means which participates in removing heat from the LRM.

Embodiments of the present invention will now be described with reference to the accompanying drawings in which:

FIGURE 1 is a perspective view of a black box having an array of LRM's therein, with one LRM removed therefrom showing the tracks of the present invention;

FIGURE 2 is an elevation view of an LRM secured in position in the black box, with the tracks secured to the frame and shown in the LRM channels in phantom; and

FIGURE 3 is an enlarged view of the connector end of a track exploded from the frame, the mother board, and the flange of the mother board connector, with a nut to be fastened on the end thereof upon assembly.

FIGURE 4 is an enlarged view of the forward track end fastened to the framework.

FIGURE 5 illustrates an alternate embodiment of the present invention with the tracks extending arcuately inwardly to engage continuous channel bottoms along the LRM under spring bias after LRM insertion.

Black box 10 includes a frame 12 to which is mounted mother board 14 having an array of mother board connectors 16 mounted thereon side by side in a closely spaced array. A plurality of line replaceable modules or LRM's 18 are mounted in black box 10 likewise arranged in a closely spaced side by side array, with each LRM having an LRM

connector 20 secured on a forward end 22 thereof in mated engagement with a respective mother board connector 16.

A pair of track members 24 extend forwardly from ends of each mother board connector 16 to the LRM-receiving opening 26 of black box 10 and are fastened at first ends 28 to frame 12 near opening 26 and at second ends 30 to a portion of frame 12 such as right angle members 32. Each LRM 18 includes channel portions 34 along sides 36 thereof at least at forward end 22 and at trailing end 38 along which tracks 24 are disposed enabling LRM 18 to be inserted into black box 10 therealong so that LRM connector 20 is laterally and axially aligned with corresponding mother board connector 16 upon full LRM insertion. A lock member 40 is then rotated into a position securing the LRM within the black box by means of a lock tab 42 being rotated behind an end portion 44 of LRM 18 as seen in Figure 2.

With particular reference to Figure 3, second end 30 of each track 24 is threaded to receive a nut 46 thereon to be fastened securely to frame member 32. Prior to nut 46 being placed thereon, second end 30 is inserted through hole 48 through flange 50 of metal shell 52 of mother board connector 16, through hole 54 of mother board 14, and through a large hole or slot 56 of frame member 32. Connector hole 48 is precisely located in connector flange 50 to correspond with the locations of terminals 58 along mating face 60 of the mother board connector, and is precisely dimensioned with respect to the diameter of track 24 so that track 24 may be inserted therethrough but not permitted lateral movement therewithin. Connector hole 48 may be counterbored to include a stop shoulder 62 cooperating with a stop shoulder 64 formed along second track end 30 at a precise distance from the right angle bend of first end 28, whereby when nut 46 is secured on end 30 the track firmly engages connector stop shoulder 62

and constitutes the primary mechanical means for holding mother board connector 16 to mother board 14. Prior to assembly of tracks 24, the mother board connectors are secured to mother board 14 by solder joints of their terminals 58 to board circuit paths or in through-holes of the board. Mother board hole 54 may be slightly larger than the portion of track end 30 extending therethrough and is aligned with connector hole 48. A slot 56 of frame member 32 is located at each connector location and extends in the direction of the array of mother board connectors, so that when mother board 14 is mounted to frame members 32 a portion of the slot is aligned with holes 48,54 to receive the threaded portion of track end 30 therethrough to be fastened with nut 46. In this embodiment tracks 24 when fastened provide the means for mounting the mother board connectors to the mother board, and further provide the means for mounting the mother board within the black box. It is easier to assemble the mother board with the array of connectors thereon, and the pairs of track members to the framework to comprise an assembly which is then placed into the outer cover of the black box and secured therein. Also it may be desirable for the black cover of the black box to be removable therefrom to enable access to the back surface of the mother board for repair thereof without first requiring removal of all LRM's and the framework from the black box to gain access to the mother board.

With particular reference to Figure 4, first track end 28 is inserted into hold 65 of frame 12 until stop shoulder 66 engages frame 12 after which nut 68 is fastened onto the threaded end portion. Stop shoulder 66 is precisely located with respect to right angle bend 70 so that when seated against frame 12 the main track portion is parallel to the opposing track and

perpendicular to mating face 60 of mother board connector 16, so that LRM 18 is axially aligned with connector 16.

An alternate embodiment of the present invention is shown in Figure 5. LRM 80 includes continuous channels 82 along side surfaces 84 thereof. Track members 86 mounted in black box 88 have a slight inwardly arcuate configuration 90 beginning just above mother board connector 92. Upon insertion of LRM 80 therealong the bottom surfaces of channels 82 engage inward configurations 90 and deflect them outwardly. After LRM 80 is secured in black box 88, the spring characteristics of the deflected track portions provides continuous intimate contact with the bottom surfaces of channels 82 substantially their entire length, which establishes a good thermal connection between tracks 86 and LRM 80. Thus tracks 86 facilitate the dissipation of heat from the LRM during in-service use. This benefit can be enhanced by forming tracks 86 from tubing and coupling the ends thereof to a fluid circulation system (not shown) to enable cooling of the LRM by a conventional refrigerating system. Aluminum tubing could be used, with aluminum having good heat conductivity characteristics and enough spring strength to be useful in this embodiment.

While it is preferred that tracks be formed of cylindrical rods or tubes, other cross-sectional configurations could be used such as a V-shape with LRM channels being V-grooves. Other fastening means could be used to secure tracks to the black box framework. Still other variations may be made to the embodiments shown without departing from the spirit of the invention or the scope of the claims.

CLAIMS:

1. A system for guiding a module during insertion into an electronic control unit enabling axial movement of the module towards a respective portion of a remote panel mounted in a framework of the control unit, said movement being in precise lateral and axial alignment therewith, the module being of the type having an electrical connector on its leading end matable with a corresponding electrical connector mounted to said panel portion, characterized in that:

a pair of opposed elongate track members each have a first end and a second end both said first and second ends are adapted to be fastened to the framework, said first end fastened to the framework forwardly of the panel portion and said second end inserted through a locating aperture of the panel portion and fastened to the framework portion therebehind, said first ends being fastened so that said pair of track members extend in parallel forwardly from said panel portion and perpendicular thereto; and

a module has opposed side surfaces associated with said pair of track members and extends from a leading end to a trailing end of said module, each said side surface including channel portions therealong at least adjacent said leading end and said trailing end cooperating with a respective said track member, whereby said module is placeable between said track members with said track members disposed in close engagement with bottom surfaces of said channels and is movable along said pair of track members toward the

respective panel portion and is laterally and axially aligned therewith upon being moved adjacent thereto.

2. A guide system as set forth in claim 1 further characterized in that said first end includes a portion extending outwardly from a right angle bend and further includes a stop shoulder engageable with a surface of the framework about an aperture through which the end portion of said first end extends to be fastened, whereby said track member is spaced a selected distance inwardly from the framework.

3. A guide system as set forth in claim 1 further characterized in that said second end includes a stop shoulder engageable with a forwardly facing stop shoulder associated with and peripherally around said locating aperture therethrough through which said second end extends to be fastened to the framework portion, whereby said track members hold the panel portion to the framework.

4. A guide system as set forth in claim 1 further characterized in that said panel is a printed circuit board having circuit means thereon and a first electrical connector is disposed precisely on the portion thereof with first electrical terminals connected to the circuit means of the board; and said module includes electrical components therewithin connected to second electrical terminals in a second electrical connector secured at a forward end of said module to be mated with said first electrical connector, said second electrical terminals being appropriately aligned with said first electrical terminals when said module is aligned by said pair of track members with the panel portion, enabling appropriate electrical engagement therebetween when said leading end of said module is moved adjacent

said first connector mounted on said panel portion.

5. A guide system as set forth in claim 4 further characterized in that said first connector includes flanges extending over said locating apertures and including holes aligned with said locating apertures through which said track members extend prior to being fastened.

6. A guide system as set forth in claim 4 wherein said track members are hollow tubes enabling fluid to be circulated therethrough to dissipate heat from said module during in-service use thereof in an electrical system.

7. A system for guiding a module during insertion into an electronic control unit substantially as described with reference to Figures 1 to 4 or 5 of the drawings.

Amendments to the claims have been filed as follows

1. A system for guiding a module during insertion into an electronic control unit enabling axial movement of the module towards a respective portion of a remote panel mounted in a framework of the control unit, said movement being in precise lateral and axial alignment therewith, the module being of the type having an electrical connector on its leading end matable with a corresponding electrical connector mounted to said panel portion to establish electrical connections between the respective electrical terminals thereof, the control unit including a pair of opposed elongate track members, each having a first end and a second end, adapted to be fastened to the framework, the first end being fastened to the framework forwardly of said panel portion and the second end being inserted through a locating aperture of the panel portion and being fastened to the framework portion therebehind, the first ends being fastened so that the pair of track members extend in parallel forwardly from the panel portion and perpendicular thereto, and the module having opposed side surfaces associated with the pair of track members and extending from a leading end to a trailing end of said module, each side surface including channel portions therealong at least adjacent the leading end and the trailing end cooperating with a respective track member, whereby the module is placeable between the track members with the track members disposed in close engagement with bottom surfaces of the channels and is movable along the pair of track members toward the panel portion and is

laterally and axially aligned therewith upon being moved adjacent thereto, said panel-mounted connector having flanges extending over the locating apertures and holes precisely positioned with respect to locations of the terminals therein, and said holes being aligned with the locating apertures through which the track members extend prior to being fastened to the framework portion thereby assuring that said second ends of the track members are disposed in a precise position with respect to the terminals of the panel-mounted connector, whereby the leading end of the module is aligned with the panel-mounted connector upon being moved adjacent thereto, and the module connector is precisely aligned with the panel-mounted connector at least immediately prior to mating enabling appropriate electrical engagement between the terminals thereof.

2. A system as claimed in claim 1, wherein said first end includes a portion extending outwardly from a right angle bend and a stop shoulder engageable with a surface of the framework about an aperture through which the end portion of said first end extends to be fastened, whereby the track member is spaced a selected distance inwardly from the framework.

3. A system as claimed in claim 1 or 2, wherein said second end includes a stop shoulder engageable with a forwardly facing stop shoulder associated with and peripherally around the locating aperture through which said second end extends to be fastened to the framework portion, whereby the track members hold the panel portion to the framework.

4. A system as claimed in claim 1, 2 or 3, wherein the track members are hollow tubes enabling fluid to be circulated therethrough to dissipate heat from the module during in-service use thereof in an electrical system.

5. A system as claimed in claim 1, 2, 3 or 4, wherein the panel is a printed circuit board including a plurality of circuit means thereon to which the terminals of the panel-mounted connector are electrically connected.

6. A system as claimed in any one of the preceding claims, wherein each of the pair of track members is slightly inwardly arcuate therealong and the track members are deflected outwardly by the bottoms of the channels of the module during insertion, and thereafter remain deflected and engage the channel bottoms under spring bias assuring substantial surface contact therewith and a good thermal connection therewith, facilitating heat dissipation from the module.

7. A system for guiding a module during insertion into an electronic control unit substantially as hereinbefore described with reference to Figures 1 to 4 or Figure 5 of the accompanying drawings.

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